

CLAIMS

1 1. Apparatus having a probe for interacting with a surface of a sample, wherein the  
2 apparatus comprises:

3 a Z actuator assembly having first and second extendable and retractable  
4 members, wherein the probe is attached to and moved by the first member;

5 the second member oriented and arranged on the Z actuator assembly with respect  
6 to the first member to synchronously move in a direction opposite that of movement of  
7 the first member such that a net momentum of the Z actuator is substantially zero upon  
8 actuation of the first and second members.

1 2. The apparatus as defined in claim 1, wherein the first and second members comprise  
2 piezo actuators.

1 3. The apparatus as defined in claim 2, wherein the piezo actuators comprise one of  
2 piezoelectric tubes, piezoelectric stacks, and piezoelectric bimorphs.

1 4. The apparatus as defined in claim 1, wherein the first and second member comprise one  
2 of voice coil actuators, electrostatic actuator, electrostrictive actuator, or magnetostrictive  
3 actuators.

1 5. The apparatus as defined in claim 1, further comprising a common central support, the  
2 first and second members being supported on opposite sides of the common central support.

1 6. The apparatus as defined in claim 1, further comprising a probe mount, the probe mount  
2 being carried by the first member.

1 7. The apparatus as defined in claim 6, further comprising a counterbalance, the  
2 counterbalance being carried by the second member.

1 8. The apparatus as defined in claim 7, wherein the probe mount and the first member  
2 together have a momentum substantially the same as a momentum of the counterbalance and the  
3 second member together.

1 9. The apparatus as defined in claim 8, wherein a mass of the first member and the probe  
2 mount is substantially the same as a mass of the second member and the counterbalance.

1 10. The apparatus as defined in claim 8, wherein a mass of the first member and the probe  
2 mount is not the same as a mass of the second member and the counterbalance.

1 11. Apparatus for measuring a surface of a sample, the apparatus comprising:  
2 a scanning member having an X actuator, a Y actuator, and a Z actuator; and

3           opposed first and second members mounted on the Z actuator, each of which is  
4           extendable and retractable in the Z direction, wherein the second member is operated to  
5           balance a momentum of the first member when the first member is extended and  
6           retracted.

1    12.    The apparatus as defined in claim 11, further comprising a probe mount mounted on the  
2    first member, the probe mount mounting a cantilever probe.

1    13.    The apparatus as defined in claim 11, wherein the X, Y, and Z actuators comprise one of  
2    a scanning tube and a scanning flexure.

1    14.    The apparatus as defined in claim 12, further including a counterbalance mounted on the  
2    second member.

1    15.    The apparatus as defined in claim 14, wherein the momentum of the first member and the  
2    probe mount together is substantially equal to the momentum of the second member and  
3    counterbalance together.

1    16.    The apparatus as defined in claim 14, wherein the mass of the first member and the probe  
2    mount together is substantially equal to the mass of the second member and counterbalance  
3    together.

1 17. The apparatus as defined in claim 16, wherein the mass of the first member and the probe  
2 mount together is not the same as the mass of the second member and counterbalance together.

1 18. Apparatus having an actuator for characterizing a surface of a sample with a probe, the  
2 actuator being extensible and retractable in a direction either toward or away from the surface,  
3 the apparatus comprising:

4 a common central support carried by the actuator;

5 a first member carried by the common central support and having a distal end  
6 which is extensible and retractable in a direction either toward or away from the surface;

7 a second member carried by the common central support and having a distal end  
8 which is extensible and retractable in a direction either toward or away from the surface,  
9 wherein the distal ends of the first and second members substantially synchronously  
10 either both extend or both retract.

1 19. The apparatus as defined in claim 18, wherein the first and second members comprise  
2 piezo actuators.

1 20. The apparatus as defined in claim 19, wherein the piezo actuators comprise one of  
2 piezoelectric tubes, piezoelectric stacks, and piezoelectric bimorphs.

1 21. The apparatus as defined in claim 18, wherein the first and second member comprise one  
2 of voice coil actuators, electrostatic actuator, electrostrictive actuator, or magnetostrictive  
3 actuators.

1 22. The apparatus as defined in claim 18, further comprising a mount assembly carried by the  
2 distal end of the first member, wherein the mount assembly comprises (i) a probe mount and (ii)  
3 a cantilever probe having a fixed end carried by the mount and including a stylus spaced from  
4 the fixed end and disposed toward the sample; and further comprising a counterbalance carried  
5 by the distal end of the second member.

1 23. The apparatus as defined in claim 22, wherein a momentum of the first member and the  
2 mount assembly together is substantially the same as a momentum of the second member and  
3 counterbalance together.

1 24. The apparatus of claim 22, further comprising a base connected to the actuator, the  
2 common central support connected to the base and wherein the common central support is  
3 electrically non-conducting, wherein the actuator is hollow and elongated, has an end portion,  
4 and includes a plurality of pins extending away from the end portion thereof, and wherein the  
5 base defines a corresponding plurality of apertures dimensioned for receiving the pins and  
6 operatively connecting the actuator and the base.

1 25. A method of reducing parasitic oscillations in an apparatus having a fast Z actuator  
2 coupled to a slow Z actuator, the fast Z actuator moving a probe which interacts with the surface  
3 of a sample, the method comprising the steps of:

4 balancing a momentum of the fast Z actuator, the momentum being generated  
5 when the fast Z actuator moves the probe relative to the surface, with an equal and  
6 opposite momentum synchronously generated in the fast Z actuator.

1 26. The method as defined in claim 25, wherein the equal and opposite momentum is  
2 generated by moving a mass equal to the mass of the fast Z actuator at a velocity equal to the  
3 velocity of the fast Z actuator.

1 27. The method as defined in claim 25, wherein the equal and opposite momentum is  
2 generated by moving a mass equal to  $1/X$  times the mass of the fast Z actuator at a velocity equal  
3 to  $X$  times the velocity of the fast Z actuator.